

# Outcomes and Satisfaction of Two Optional Cadaveric Dissection Courses: A 3-Year Prospective Study

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Teaching time dedicated to anatomy education has been reduced at many medical schools around the world, including Nova Medical School in Lisbon, Portugal. In order to minimize the effects of this reduction, the authors introduced two optional, semester-long cadaveric dissection courses for the first two years of the medical school curriculum. These courses were named Regional Anatomy I (RAI) and Regional Anatomy II (RAII). In RAI, students focus on dissecting the thorax, abdomen, pelvis, and perineum. In RAI, the focus shifts to the head, neck, back, and upper and lower limbs. This study prospectively analyzes students' academic achievement and perceptions within the context of these two, newly-introduced, cadaveric dissection courses. Students' satisfaction was assessed anonymously through a questionnaire that included items regarding students' perception of the usefulness of the courses for undergraduate teaching, as well as with regards to future professional activity. For each of the three academic years studied, the final score (1 to 20) in General Anatomy (GA), RAI, and RAI was on average  $14.26 \pm 1.89$ ;  $16.94 \pm 1.02$ ;  $17.49 \pm 1.01$ , respectively. The mean results were lower in GA than RAI or RAI ( $P < 0.001$ ). Furthermore, students who undertook these courses ranked them highly with regards to consolidating their knowledge of anatomy, preparing for other undergraduate courses, and training for future clinical practice. These survey data, combined with data on participating students' academic achievement, lend strong support to the adoption of similar courses as complementary and compulsory disciplines in a modern medical curriculum. *Anat Sci Educ* 00: 000–000. © 2016 American Association of Anatomists.

**Key words:** gross anatomy education; medical education, undergraduate education teaching methods; cadaver dissection; medical curriculum; student satisfaction; questionnaires; prospective study

Additional Supporting Information can be found in the online version of this article.

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## INTRODUCTION

Time allocated to anatomy education for medical students has suffered a steady decline around the world, including not only within the United States (Drake et al., 2009; Sugand et al., 2010) and Europe (Grković et al., 2009; Moxham et al., 2011; Nutt et al., 2012; Pais et al., 2013; Moxham et al., 2015a,b), but also Africa (Boon et al., 2001; Kinfu, 2008), India (Holla et al., 2009; Jacob, 2013), and Australia (Craig

et al., 2010; Herle and Saxena, 2011). This has also been observed in recent years at Nova Medical School in Lisbon (Portugal).

As in most Portuguese medical schools, anatomy education at Nova Medical School at the undergraduate level formerly consisted of two annual courses (Anatomy I and Anatomy II) taught in the first and second year of a six-year-long medical curriculum. In Anatomy I, students covered the locomotor system, the digestive system, the genitourinary system, and the lymphoid organs. In Anatomy II, the curriculum consisted of the central and peripheral nervous systems, the cardiovascular system, and the sense organs (Pais et al., 1998, 1999).

Each of these annual courses were traditionally taught over a 28-week period. Each week, there were two 50-minute lectures and two 110-minute practical sessions. Each lecture was preceded by a summary of the material to be covered, followed by a period at the end to answer students' questions. During the practical sessions, students discussed the course content among themselves and with the teaching staff. In addition, during these practical sessions students examined anatomical models, utilized teaching software, and prosected cadaveric specimens. Moreover, in eight of these practical sessions students participated in cadaveric dissection (Pais et al., 1998, 1999). Overall, before the present curricular reform, anatomy was taught for a total of 336 hours.

However, following the academic year 2010/2011, anatomy was shifted into the first semester of medical school (the General Anatomy course, in which cadaveric dissection was not performed), and was rescheduled to be included as part of the syllabus of two biannual courses in the second year of the medical curriculum (Fundamentals of Neuroscience and Radiological and Clinical Anatomy). The General Anatomy (GA) course is now taught for a total of 112 hours (56 hours of lectures, and another 56 hours of practical classes). The Fundamentals of Neurosciences and the Radiological and Clinical Anatomy courses have a total of 29 and 23 hours devoted to anatomy education, respectively. Lectures and practical courses each occupy roughly half of the time dedicated to these two courses. Overall, the introduction of the curricular reform in the medical school resulted in a decrease from 336 to 164 hours devoted to anatomy education. This, in turn, corresponded to a 51.2% net reduction in the time spent teaching anatomy at the undergraduate level.

In order to minimize the deleterious effects of this reduction in the time devoted to anatomy education, several authors have proposed reinforcing the importance of practical cadaveric dissection in either classical anatomical courses or in optional dissection courses (Winkelmann, 2007; Sugand et al., 2010; Kerby et al., 2011; McNulty et al., 2016). In order to support these proposals, objective evidence related to the utility of practical cadaveric dissection, assessed by student performance evaluations, as well as surveying student perceptions, needs to be prioritized (Winkelmann, 2007; Pais and Moxham, 2013).

In order to broaden the anatomical learning experience at the undergraduate level through cadaveric dissection, the senior author of the present study (D.P.) strove to introduce two optional, semester-long cadaveric dissection courses to the first 2 years of the medical curriculum. To objectively evaluate the results of this experience, student academic performance and perceptions regarding these two courses were prospectively evaluated over a 3-year period.

The primary aim of this study was to compare the academic success and satisfaction of undergraduate medical students undertaking an optional dissection course with those of a similar cohort not exposed to cadaveric dissection in the context of a curricular reduction in the time spent teaching anatomy.

## MATERIALS AND METHODS

### Characterization of the General Anatomy Course

The General Anatomy (GA) course is a required subject, held over 14 weeks during the first semester of the first year of a 6-year medical curriculum (Table 1). At the end of the course, students undertake a 6-week-period of study and examinations. The course's syllabus encompasses the gross anatomy of the locomotor system (osteology, arthrology, and myology), the major organ systems, the cardiovascular system, and the peripheral nervous system.

The course is composed of both a theoretical and a practical component. The former consists of four 50-minute lectures per week. Before the start of the course, detailed information is provided regarding the necessary prerequisite knowledge, the subject summary, and recommended bibliography for each lecture. In addition, self-examination exercises are supplied to students for each lecture.

The practical component of the GA course corresponds to two 110-minute practical classes per week. Each practical class contains no more than 15 students. The teaching modalities employed in the practical course consist of tutorial education; observation and discussion regarding anatomical models and previously prosected cadaver specimens; and presentation and discussion of bibliographic research performed by students in the context of the GA course's syllabus. The final score in the GA course is determined by ongoing evaluations during the practical course (30% of the score), by a midterm written evaluation on the locomotor system (20% of the score), and by a final oral examination (50% of the score). This latter examination is conducted by at least three different senior staff members of the Department of Anatomy. During the oral examination, students are interviewed regarding the subjects taught throughout the GA course. The final score from the oral examination consists of an average of the evaluations performed by each staff member. To pass the GA course, students must score at least 10 (in a scale of 0 to 20) in each evaluation component.

### Characterization of the Optional Regional Anatomy Dissection Courses

The two optional dissection courses are designated "Regional Anatomy I" (RAI) and "Regional Anatomy II" (RAII). First and second year medical students may apply for one of the 60 and 70 available positions for RAI and RAI, respectively. These positions are assigned on a "first come, first served" basis. In RAI, the regions dissected consist of the thorax, abdomen, pelvis, and perineum. For RAI, students focus instead on the head, neck, back, and upper and lower limbs.

These optional dissection courses are taught after the GA course, starting during the second semester of the first and second year of medical school. Each of these courses lasts for 14 weeks, and each consists of at least 14 practical sessions

**Table 1.**

Characterization of the General Anatomy, Regional Anatomy I, and Regional Anatomy II courses at Nova Medical School in Lisbon

Characteristics	General Anatomy		Regional Anatomy I	Regional Anatomy II
Enrollment	Compulsory		Voluntary (60 places taken on a "first come first served" basis)	Voluntary (70 places taken on a "first come first served" basis)
Average number of students enrolled each academic year ( $\pm$ SD)	220 ( $\pm$ 7.9)		60 ( $\pm$ 0)	70 ( $\pm$ 0)
Year of medical school	First year		First and/or second year	First and/or second year
Duration (weeks)	14		14	14
Course structure	Theoretical course (four 50-minute lectures per week; 56 in total); Practical course (two 110-minute practical classes per week; 28 in total)		At least 14 practical human cadaver dissection sessions (120 minutes each)	At least 14 practical human cadaver dissection sessions (120 minutes each)
Teaching modalities	Lectures; Practical classes including: • Tutorials; • Observation and discussion with anatomical models and dissected specimens; • Presentation of bibliographic research pertaining to the syllabus of the course		Introductory 10-minute lecture at the beginning of each class; Supervised dissection; Near-peer coaching; Discussion based on cadaveric dissection in small groups	Introductory 10-minute lecture at the beginning of each class; Supervised dissection; Near-peer coaching; Discussion based on cadaveric dissection in small groups
Assessment methods (% of the contribution to the final score)	Continuous assessment in the practical course (30%); • Midterm written test (20%); • Final evaluation: • oral examination (50%)		Continuous assessment in the practical course (50%); Final evaluation: • Presentation of dissected specimens (25%); • Written test (25%)	Continuous assessment in the practical course (50%); Final evaluation: • Presentation of dissected specimens (25%); • Written test (25%)
Mean age years ( $\pm$ SD)	22.34 ( $\pm$ 7.92)		20.56 ( $\pm$ 5.52)	25.44 ( $\pm$ 8.76)
Gender	33.0% M; 67.0% F		35.1% M; 64.9% F	37.1% M; 62.9% F

The demographic data (average number of students enrolled, students' mean age and gender) refers to the academic years 2012/2013 to 2014/2015; Numeric values are expressed as average values  $\pm$  standard deviation; M, male; F, female.

with human cadaveric dissection in the anatomical dissection room. Classes are taught on Thursdays, as this day is dedicated to the optional courses in the second semester of the first two years of the medical curriculum. Additional classes and dissection times are frequently arranged according to student interest and teaching staff availability. These additional meetings vary between 4 and 7 per course and per academic year. They typically take place on Wednesday mornings or Thursday afternoons during periods when students do not have other classes, allowing all students to attend these extra sessions if they wish to do so. These extra classes are primarily used for providing extra dissection time under the supervision of the course's teaching staff.

Both courses (RAI or RAII) consist of 3 credits according to the European Credit Transfer and Accumulation System (ECTS). A total of 360 credits of the ECTS are required to complete the six-year medical degree.

At the beginning of each class, a member of the teaching staff provides a brief, ten-minute talk on the practical aspects of the dissection of one of the regions studied, as well as on the most prominent anatomical structures found in that region. For the remaining 110 minutes, each student group dissects two distinct anatomical regions on the anterior aspect of the cadaver (in the first half of the course), followed by another two anatomical regions on the posterior aspect (in the second half of the course). During each practical session, there are six dissection groups for each cadaver, which allows all students to work together simultaneously. The chronological sequence of the regions to be dissected anteriorly and posteriorly is established before commencing the course. A dissection checklist comprising the most important anatomical structures in each plane of each region is also available before the course's commencement. These checklists, as well as the handouts of the lecturers' presentations, cover most of the anatomical knowledge students are required to learn during the dissection courses, and are made available to students at the beginning of the course.

There are six embalmed cadavers available for RAI and seven embalmed cadavers available for RAII. Because of a special embalming method developed in the Department of Anatomy at Nova Medical School (Goyri-O'Neill et al., 2013), the cadavers retain most of their original characteristics, with minimal odor and without causing discomfort in participants. Groups of 9 to 10 students are assisted by at least one junior and one senior teaching staff member. The junior staff member is frequently a senior medical student completing the last two years of medical school. On all occasions, at least one professor from the Department of Anatomy is present. The senior author (D.P.) supervises both optional courses.

All students are provided a final mark for the course that ranges between 0 and 20. Half of this mark is provided by the two members of the staff that assisted the student during the entire duration of the course, and this is based on a class-by-class assessment of multiple evaluation parameters explicitly established before the start of the course. These parameters consist of anatomical knowledge, critical analysis and application of knowledge, ability to identify anatomical structures, dissection technique, following safety measures, respect for the cadaver, interest, initiative, motivation, communication skills, ability to work in a group, and punctuality. A quarter of the final mark is determined by a written examination at the end of the course that tests the student's fundamental anatomical knowledge pertaining to the anatomical

regions dissected. The written examination is different for each examination season, although it follows a homogenous structure that is similar to that of the GA written examination. The remaining quarter of the final mark is derived from an oral presentation of one of the regions dissected by each student. Although students present anatomical regions in groups, each student is required to present part of the dissection individually. Hence, students are evaluated independently according to their anatomical knowledge, critical analysis and application of knowledge, ability to identify anatomical structures, and communication skills. In order to pass the course, each student must have a score  $\geq 10$  (with possible scores ranging from 0 to 20) for each parameter.

To optimize the consistency and reliability of evaluations, and to minimize potential heterogeneity in the enthusiasm and in the amount of attention provided by the teaching staff in the GA, RAI, and RAII courses, all teachers involved in the optional dissection courses also taught and graded the GA course. Moreover, more than half of the senior teaching staff taught both RAI and RAII.

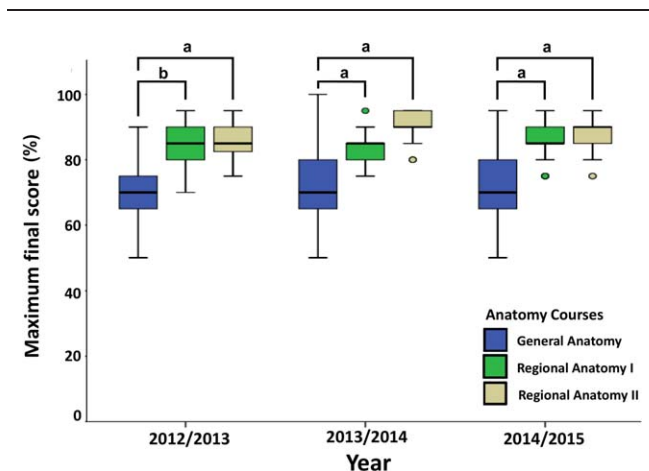
The final score of each student attending RAI and RAII during three consecutive academic years (2012/2013; 2013/2014; 2014/2015) was prospectively recorded.

During these three years, at the end of each course (after completing the final examination and before knowing their final marks), students were invited to complete an anonymous validated written questionnaire (Cronbach's  $\alpha = 0.90$ ) regarding their personal experience while attending the course, as well as their evaluation of the course (the English translation of the questionnaire used in this study can be found in the supplementary materials). The questionnaire was devised before the introduction of the two optional dissection courses, and it was applied prospectively. It included the following parameters: proportion of the total time spent studying for all courses in that semester that was occupied with studying for the anatomy course (expressed as a percentage); importance of the course in terms of consolidating knowledge of anatomy (consolidation was defined as "a learning stage where new material is reviewed, facilitating the acquisition of new knowledge" (Nadel et al., 2012)); importance of the course as preparation for other courses in undergraduate medical training; importance of the course for future professional activity; articulation of the course with other courses attended during the same year of medical school; importance of the introductory lectures at the beginning of each class; adequacy of the handouts of the lecture slides for study and dissection preparation; adequacy of the dissection checklist for the dissections performed; adequacy of cadaveric material for the course; and quality of practical dissection coaching by the anatomy department staff members.

Categorical answers were graded by students using a five-point Likert scale: 1, bad/none; 2, unsatisfactory/little; 3, satisfactory/reasonable; 4, good/significant; 5, very good/very much.

The questionnaire was developed by both the Department of Medical Education and by the Anatomy Department. Briefly, the questionnaire was constructed through the following steps: The goals of the questionnaire were clearly defined: (1) to characterize the demographic features of students attending anatomy courses at Nova Medical School, as well as to determine their prior anatomy training; (2) to evaluate students' attitudes towards several aspects of the course using a typical five-point Likert scale; (3) ask students in an open question format to produce comments, criticisms, or





**Figure 1.**

Final scores of students attending anatomy courses at Nova Medical School in the academic years 2012/2013 to 2014/2015. Box plots representing the final results in the optional dissection courses (Regional Anatomy I and II) compared to the General Anatomy mandatory course during three consecutive years. Statistically significant differences are highlighted; <sup>a</sup> $P$ -value < 0.001; <sup>b</sup> $P$ -value = 0.001.

suggestions regarding the course's usefulness, general organization, curriculum, teaching modalities, evaluation methods, and teacher/student interaction.

Questions were devised by both the authors and members of the Department of Medical Education, independently. The questions were then discussed collectively. A preliminary set of questions was produced by consensus, resulting in the production of a pilot questionnaire. The pilot questionnaire was tested on a group of 30 first-year medical students after finishing a dissection course. These students were also asked to fill in the questionnaire a month after the completion of the course in order to analyze the reliability of each question.

After the students had completed the questionnaire for the second time, the researchers interviewed the students individually to identify the most problematic questions, in order to edit them or eliminate them from the final questionnaire.

Under the guidance of a professional statistician, the five-point Likert scale questions that demonstrated poor validity and reliability using Kendall's tau B and Cronbach's alpha were discarded. Qualitative data obtained from question 17 of the aforementioned questionnaire (see supplementary material) were coded through a two-step process in order to facilitate data analysis (Li and Finkelstein, 2008; Barnett-Page and Thomas, 2009). In the first step, basic themes were distinguished (course's usefulness, general organization, and teaching modalities). In the second step, the first (D.P) and second (D.C.) authors produced specific categorical codes after observing content iteration in the answers given by students regarding the different themes.

The study's protocol was approved by the Ethical Committee at Nova Medical School.

## Statistical Analysis

The data was inserted into an Excel® database (Microsoft Corp., Redmond WA). Qualitative variables were expressed

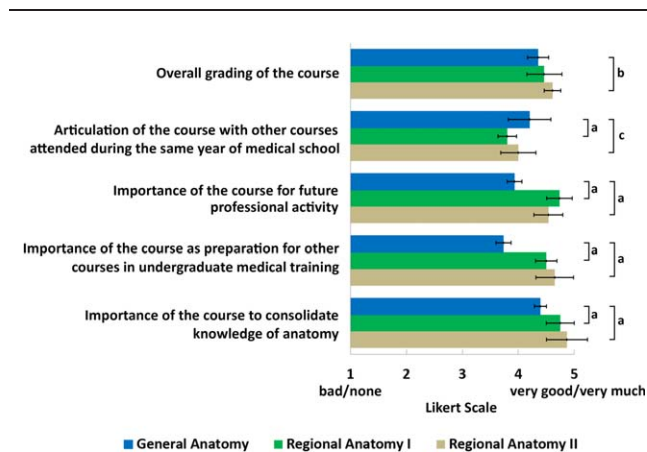
as percentages. Quantitative variables were expressed as means  $\pm$  standard deviation. The SPSS software, version 21.0 (IBM Corp., Armonk, NY) was used for descriptive and inferential statistical analysis. The Kolmogorov-Smirnov test was used to assess whether variables were normally distributed. T-Student and ANOVA tests were used to compare averages for normally distributed data for two and more than two groups, respectively. Mann-Whitney U and Kruskal-Wallis tests were applied to compare means for non-normally distributed data in cases of comparison between two groups or comparison between more than two groups, respectively. Proportions were analyzed with the Chi-square test, unless at least one of the variables had expected values under 5, in which case Fisher's exact test was employed. Dichotomous variables were compared with the binomial test. Correlations between continuous variables were tentatively sought using Pearson's Product Moment Correlation. Kendall's tau-b ( $\tau_b$ ) correlation coefficient was the nonparametric tool used to measure the strength and direction of association between two variables measured on at least an ordinal scale. A two tailed  $P$ -value below 0.05 was considered to be statistically significant.

## RESULTS

There was a total of 660 students enrolled in the General Anatomy (GA) course over the period of the study, and 180 and 210 students attending the RAI and RAII courses, respectively (Table 1). Fifty-three students (8.3%) attended both of the optional dissection courses. There were more females than males in the three courses ( $P < 0.05$ ). The ratio of males to females did not vary significantly between the three courses. Students' average age was higher in the GA course ( $22.34 \pm 7.92$ ) than in the RAI course ( $20.56 \pm 5.52$ ), and higher in the RAII course ( $25.44 \pm 8.76$ ) than in the GA course ( $P < 0.001$ ). Questionnaires were obtained and analyzed from 345 students who attended the GA course, 171 from students who attended RAI, and 195 from those who attended RAII. This corresponded to a response rate of 52.3%, 95.0%, and 92.8% from the GA, RAI and RAII courses, respectively. This rate was higher in the optional dissection courses ( $P < 0.001$ ).

Figure 1 shows the final results in the anatomy courses at the authors' institution from 2012/2013 to 2014/2015. During this period, the final score (1 to 20) in GA, RAI, and RAII was on average  $14.26 \pm 1.89$ ;  $16.94 \pm 1.02$ ;  $17.49 \pm 1.01$ , respectively. The mean results were lower in GA than RAI or RAII ( $P < 0.001$ ). The difference between the mean final scores of RAI and RAII was not statistically significant.

When considering only the students who had attended at least one of the two optional dissection courses, the average final score was  $14.35 \pm 3.82$ ;  $16.90 \pm 1.58$ ; and  $17.24 \pm 2.26$  in the GA, RAI and RAII courses, respectively. Among the 8.3% of students who took the two optional dissection courses, the average final score in the GA, RAI, and RAII courses was  $14.42 \pm 4.02$ ;  $16.53 \pm 1.37$ ; and  $17.63 \pm 2.01$ , respectively. No statistically significant differences could be found between the students who took one of the optional dissection courses compared to those who took both optional dissection courses. The average final score in the GA course was  $13.37 \pm 4.07$  among the group of students who did not take any of the optional dissection courses, which was significantly lower than that among the students who took at least one of the latter courses ( $P < 0.05$ ). Performing pairwise



**Figure 2.**

Horizontal bar graph showing the opinions of students on the two optional dissection courses, expressed as mean values. Error bars show the standard error of the mean. Categorical answers were graded by students on a five-point Likert scale where 1 = bad/none, 2 = unsatisfactory/little, 3 = satisfactory/reasonable, 4 = good/significant, and 5 = very good/very much; <sup>a</sup> $P < 0.0001$ ; <sup>b</sup> $P < 0.001$ ; <sup>c</sup> $P < 0.05$ .

comparisons of the final marks obtained by individual students in each of these courses, scores were significantly higher among the optional dissection courses than in the GA compulsory course ( $P < 0.0001$ ). Interestingly, there were statistically significant correlations between the scores obtained in GA and both RAI (Pearson's correlation coefficient 0.332;  $P < 0.0001$ ) and RAI (Pearson's correlation coefficient 0.408;  $P < 0.0001$ ).

Failure rates in the GA, RAI, and RAI were 15.7%, 0.0%, and 0.0% in the academic year 2012/2013; 16.8%, 2.8%, and 5.7% in the academic year 2013/2014; and 17.5%, 0.0%, and 0.0% in the academic year 2014/2015. Failure rates were higher in the GA course than in the optional dissection courses ( $P < 0.001$ ).

**Table 2.**

Evaluation of the Dissection Courses' Structure and Teaching

Statement	Regional Anatomy I (N = 171)	Regional Anatomy II (N = 195)
	Mean (±SD)	Mean (±SD)
Importance of the introductory lectures at the beginning of each class	4.19 (±1.04)	4.18 (±1.52)
Adequacy of handouts of the lecture slides for study and preparation for dissection	4.34 (±1.31)	4.11 (±1.37)
Adequacy of checklists for the dissections performed	4.17 (±0.89)	4.45 (±0.65)
Adequacy of cadaveric material for the course	4.53 (±0.60)	4.39 (±0.43)
Quality of practical dissection coaching by anatomy staff members	4.65 (±0.85)	4.72 (±0.57)

Each parameter was evaluated on a five-point Likert scale where: 1 = bad/none, 2 = unsatisfactory/little, 3 = satisfactory/reasonable, 4 = good/significant, 5 = very good/very much; Values are expressed as mean values ± standard deviation; N, number of questionnaires obtained in Regional Anatomy I and II courses; No statistically significant differences were found between the two courses for each parameter assessed.

On average, the percentage of time each student reported studying for each anatomy course relative to the time spent studying for all courses in that semester was  $64.0 \pm 17.3\%$  for GA,  $23.7 \pm 17.0\%$  for RAI, and  $27.6 \pm 18.3\%$  for RAI. This value was higher for GA than for the Regional Anatomy courses ( $P < 0.001$ ). No statistically significant difference was found between the proportion of time spent studying for the two optional dissection courses.

Figure 2 illustrates students' perceptions of the importance of the anatomy courses. The perceived importance of RAI and RAI in consolidating students' anatomy knowledge ( $4.75 \pm 0.60$  and  $4.87 \pm 1.21$ ) was higher than that of the GA course ( $4.39 \pm 0.38$ ;  $P < 0.0001$ ). Similarly, students ranked the importance of the two dissection courses higher in terms of preparing them for other undergraduate courses than for the GA course ( $4.5 \pm 0.78$  [RAI];  $4.65 \pm 1.1$  [RAI]; and  $3.73 \pm 0.35$  [GA];  $P < 0.0001$ ). Similarly, students highly ranked the importance of the RAI and RAI courses with regards to their future professional activity ( $4.74 \pm 0.89$  and  $4.54 \pm 0.90$  for RAI and RAI respectively). These scores were on average superior to those associated with the GA course ( $3.93 \pm 0.49$ ;  $P < 0.0001$ ). Regarding the articulation of the anatomy courses with other courses attended by students during the same year of medical school, students graded the GA course ( $4.2 \pm 1.2$ ) better than RAI ( $3.8 \pm 0.59$ ;  $P < 0.0001$ ) or RAI ( $4.0 \pm 0.78$ ;  $P = 0.037$ ). With regards to overall grades, students in RAI and II obtained better scores ( $4.46 \pm 0.98$ ; and  $4.61 \pm 0.45$ , respectively) than in GA ( $4.35 \pm 0.90$ ). However, this difference was statistically significant only between RAI and GA ( $P = 0.002$ ).

The average scores evaluated by students regarding the different parameters of the organization, structure, and teaching support of the dissection courses are highlighted in Table 2. All assessed parameters had an average score of at least 4, in a scale of 1 to 5. Most students classified each item as "Good" (4) or "Very good" (5).

Content analysis of the qualitative data obtained in question 17 revealed that the percentage of students reporting that the course's content was useful or very useful was 29.5%, 26.3%, and 26.1% in GA, RAI, and RAI, respectively (Table 3). With regards to the general organization of the course, 28.9%, 33.9%, and 35.8% of students attending

Table 3.

Content Analysis of the Qualitative Data Obtained in the Open-Ended Question

General anatomy (N = 345)	Regional anatomy I (N = 171)	Regional anatomy II (N = 195)
<b>Theme 1: Course's usefulness</b>		
<ul style="list-style-type: none"> <li>Useful or very useful (29.5%)</li> <li>Grants an overall view of human gross morphology (10.7%)</li> </ul> <p><i>"This course allowed me to learn the correct nomenclature of the major structures that make up the systems of the human body, as well as the terminology required for their description. This information will be instrumental for my future learning and working needs."</i></p>	<ul style="list-style-type: none"> <li>Useful or very useful (26.3%)</li> <li>Helped consolidate knowledge of anatomy (34.1%)</li> </ul> <p><i>"RAI allowed me my first contact with death."</i></p> <p><i>"This course permitted an in-depth knowledge of all the main features of the anatomical structures dissected, as well as their relationship with neighboring structures"</i></p>	<ul style="list-style-type: none"> <li>Useful or very useful (26.1%)</li> <li>Helped consolidate knowledge of anatomy (33.3%)</li> </ul> <p><i>"This dissection course allows a hands-on approach to anatomy similar to that which will be required in clinical practice, namely in many surgical procedures"</i></p> <p><i>"RAII allows the various anatomical structures and the relations they establish among themselves to be integrated in a regional perspective, similar to that which will be required in the clinical setting"</i></p>
<b>Theme 2: General organization</b>		
<ul style="list-style-type: none"> <li>Good, very good or excellent (28.9%)</li> </ul>	<ul style="list-style-type: none"> <li>Good, very good or excellent (33.9%)</li> </ul>	<ul style="list-style-type: none"> <li>Good, very good or excellent (35.8%)</li> </ul>
<b>Theme 3: Teaching modalities</b>		
<ul style="list-style-type: none"> <li>Good, very good or excellent (20.9%)</li> <li>Discussion of clinical correlations were a good way of consolidating knowledge of anatomy (8.7%)</li> <li>Complained that by being deprived of active dissection they felt they were not allowed to have a realistic view of anatomy (14.8%)</li> </ul> <p><i>"The GA course provides an excellent theoretical basis for learning anatomy. However, knowledge acquisition and application could be improved by continuous cadaveric dissection for the duration of the course."</i></p> <p><i>"On occasion the emphasis placed on memorization was disheartening."</i></p>	<ul style="list-style-type: none"> <li>Good, very good or excellent (40.9%)</li> <li>Promoted manual dexterity (16.4%)</li> <li>The close proximity-coaching by faculty members facilitated learning and increased motivation (2.9%)</li> </ul> <p><i>"This dissection course allowed a more practical approach to what had already been taught in the GA Course."</i></p> <p><i>"Group dissection stimulated tolerance amongst students."</i></p> <p><i>"Using dissection instruments promoted situational awareness and careful dissection techniques to avoid injuring fellow students"</i></p>	<ul style="list-style-type: none"> <li>Good, very good or excellent (42.6%)</li> <li>Promoted manual dexterity (17.9%)</li> <li>The close proximity-coaching by faculty members facilitated learning and increased motivation (3.5%)</li> </ul> <p><i>"Dissection in small groups promoted group working skills."</i></p> <p><i>"Knowing that the cadavers used in classes were from individuals who had willingly donated their bodies so that we could be better doctors was both humbling and encouraging!"</i></p>

Text of Question 17: "Could you please make some comments, suggestions, and/or criticisms regarding this course's usefulness, general organization, curriculum, teaching modalities, evaluation methods and teacher/student interaction?"; Data were analyzed through a two-step process. In the first step, basic themes were distinguished (in bold letters in the left column). In the second step, the first and second authors elucidated specific categories within each theme based on content iteration in the answers given by students regarding the different themes; In italics are the transcription of some of the representative comments provided by students regarding each theme; N, number of questionnaires obtained in each anatomy course; GA, General Anatomy; RAI, Regional Anatomy I; RAI, Regional Anatomy II.

GA, RAI, and RAI considered it good, very good, or excellent, respectively. Only 20.9% of the GA students spontaneously described the teaching modalities as good, very good or excellent, compared to 40.9% of RAI, and 42.6% of RAI students ( $P < 0.01$ ).

Several students in the RAI (19.8%) and RAI (12.2%) courses mentioned that these dissection courses had several benefits in addition to those already specified in the courses' aims. As one RAI student summarized, "RAI allowed me my first contact with death." Another RAI student added that "This dissection course gave a more practical approach to what had already been taught in the General Anatomy

course." This latter opinion was endorsed by several of the RAI and RAI participants, namely a RAI student who wrote "This dissection course allows a hands-on approach to anatomy similar to that which will be required in clinical practice, namely in many surgical procedures." Multiple students (33.6%) attending the dissection courses mentioned that these courses helped consolidate their knowledge of anatomy. A substantial proportion of students attending RAI (16.4%) and RAI (17.9%) believed that cadaveric dissection increased their manual dexterity. The close coaching by a senior and a junior anatomy educator was considered to facilitate learning and to increase motivation to study by

2.9% and 3.5% of students attending RAI and RAII, respectively.

In contrast, several GA students (14.8%) complained that, by being deprived of active dissection, they felt that they were not allowed to have a realistic experience of anatomy.

## DISCUSSION

Shorter anatomy courses in medical curricula worldwide have been associated with suboptimal learning. (Pabst, 1993; McLachlan et al., 2004; Turney, 2007; Drake et al., 2009; Grković et al., 2009; Moxham et al., 2011; Nutt et al., 2012; Pais and Moxham, 2013; Drake et al., 2014; Moxham et al., 2015a,b). It has been argued that this deficiency could be partly circumvented through supplemental anatomy education (Sawyer et al., 1996; Forester et al., 2004; Cantwell et al., 2015) and by active cadaveric dissection (Ellis, 2001; Older, 2004; Winkelmann, 2007; Holla et al., 2009). In order to test this hypothesis, a few studies have been conducted on the merits of dissection at the undergraduate level in medical schools (Nnodim, 1996; Nnodim et al., 1996; Leong, 1999; Snelling et al., 2003; Arora and Sharma, 2011). The present investigation contributes to the research in this field by prospectively analyzing students' academic performance and perception with regards to two newly introduced cadaveric dissection courses in the context of a recent anatomy curriculum reduction at the authors' medical school. Hence, this study has the benefit of being one of the few to prospectively evaluate undergraduate students' academic performance and satisfaction while undertaking an optional dissection course, and comparing these results with those of a similar cohort who did not have the same opportunity. To the best of the authors' knowledge, this is the first prospective study of its kind reported not only in Portugal, but also in the Iberian Peninsula and southern Europe.

Regarding students' anatomical knowledge, this data revealed that for each of the three academic years studied, better final scores and lower failure rates were obtained in the optional dissection courses than in the compulsory GA course ( $P < 0.01$ ) (Fig. 1). This may be partly explained by the fact that dissection courses boost medical students' motivation to study and learn anatomy (Burgess and Ramsey-Stewart, 2014). Indeed, several authors have demonstrated that anatomical courses including cadaveric dissection result in students faring better in anatomy examinations (Biasutto et al., 2006).

Furthermore, it should be noted that students undertaking both dissection courses highly ranked the importance of these courses in consolidating their knowledge of anatomy, as preparation for other undergraduate courses, and for future clinical practice (Fig. 2). In this regard, the two dissection courses received higher grades for their role in accomplishing each of these purposes than the traditional GA course ( $P < 0.001$ ).

The only parameter in which the GA course received a better evaluation than the RAI and RAII courses was with regards to its articulation with other courses attended by the students in the same year of medical school. The authors believe that this may be due to the fact that most courses during the first two years of medical school are mostly theoretical and systematically cover the entire human body, whereas the two optional dissection courses described in this paper are mostly practical and refer to specific regions of the body.

Reviewing the literature, there is a consensus that undergraduate anatomical dissection has been shown to not only

familiarize students with normal topography and morphology (Pabst, 1993; McLachlan et al., 2004), but also to enhance three-dimensional orientation, dexterity (McLachlan and Patten, 2006), teamwork skills (Böckers et al., 2010; Moxham et al., 2011), and other professional competencies among medical students (Gogalniceanu et al., 2008; Pais and Moxham, 2013; Moxham et al., 2015a,b). Additionally, the experience of cadaveric dissection is universally described by medical students and doctors as a unique ritual of initiation in the medical profession, heightening students' drive and motivation to become a better doctor (Dyer and Thorndike, 2000; Moxham and Plaisant 2007; Korf et al., 2008; Leboulanger, 2011).

However, although there is substantial evidence supporting the use of cadavers in this context (Korf et al., 2008; Regan de Bere and Mattick, 2010; Naz et al., 2011; Burgess and Ramsey-Stewart, 2014; Marshak et al., 2015), there are also some conflicting viewpoints. (Winkelmann, 2007; Hill and Shalhoub, 2011). In particular, time, finance, and ethical constraints have curbed enthusiasm for cadaveric dissection in many places. (Warnick, 2004; Winkelmann and Guldner, 2004; Gogalniceanu et al., 2008).

The present survey found that students very favorably graded the structure of the two dissection courses, as well as the close coaching by a senior and a junior anatomy teacher (Tables 1 and 3). In fact, this interaction was found to facilitate learning and increase motivation in 2.9% and 3.5% of students' perceptions attending RAI and RAII, respectively. This teaching anatomy model, in which students are supervised by a near-peer (frequently a final year medical student), has been demonstrated to facilitate learning in a practical setting such as that described herein (Evans and Cuffe, 2009; Durán et al., 2012). This model has been shown to be advantageous for both junior teachers and students, which seems to be supported by the present data (Evans and Cuffe, 2009; Cheng et al., 2011; Durán et al., 2012; Erie et al., 2013; Scott et al., 2014).

The authors believe that the improved academic performance observed associated with students' positive opinions in attending the two dissection courses lend support to the adoption of similar courses as complementary and compulsory disciplines in a modern medical curriculum (Pabst, 1993; Dyer and Thorndike, 2000; McLachlan and Patten, 2006; Turney, 2007; Gogalniceanu et al., 2008; Korf et al., 2008; Drake et al., 2009; Grković et al., 2009; Böckers et al., 2010; Leboulanger, 2011; Moxham et al., 2011; Nutt et al., 2012; Pais and Moxham, 2013; Drake et al., 2014; Moxham et al., 2015a,b).

Hence, the two major reasons for curtailing cadaveric dissection in most modern curricula, namely higher cost and limited time devoted to anatomy, should be made secondary to the unique gains obtained with this teaching modality.

## Study Limitations

An important limitation inherent to all studies comparing different courses, as in the study herein described, is that in addition to the different teaching modalities employed, there are also differences between the courses regarding structure and assessment methods. However, in the present study other important variables were remarkably similar, namely the courses' duration and students' age and gender distribution. In fact, this study used the same student population during



the same period of time, making the differences between those who attended the dissection courses and those who did not more likely to be at least in part due to the experience of cadaveric dissection.

It must be noted that the positive student evaluations regarding RAI's and RAII's structure and teaching may be biased due to the fact that these optional dissection courses were most probably chosen by students with a keen interest in anatomy. Indeed, in this study, the average final score in the GA course was significantly lower among the group of students who did not take any of the optional dissection courses compared to that obtained by the cohort of students who chose to take at least one of the latter courses ( $13.37 \pm 4.07$  versus  $14.35 \pm 3.82$ ;  $P < 0.05$ ). Since the GA course preceded the optional dissection courses in the curriculum, these data suggest that the students that undertook the optional dissection courses already had a greater interest in learning anatomy.

Moreover, the students' improved academic performance demonstrated in the optional dissection courses relative to the GA course, despite the longer number of hours devoted to the latter course, may be partially due to the fact that a smaller number of students in the optional dissection courses allowed for more individual attention from faculty members.

In addition, the percentage of time each student reported studying for each anatomy course relative to the time spent studying for all the courses in that semester was on average higher for GA than for any of the Regional Anatomy courses ( $64.0 \pm 17.3\%$  for GA,  $23.7 \pm 17.0\%$  for RAI, and  $27.6 \pm 18.3\%$  for RAII;  $P < 0.001$ ). This difference may be a result of the fact that the students participating in the RA courses are potentially stronger students, and thus require less study time than their counterparts. However, it may also be argued that by allowing an eminently practical approach to anatomy, the optional dissection courses made learning easier and, therefore, less time consuming.

Consequently, the authors acknowledge that caution should be used when extrapolating the findings of this study to the general student population. Hence, it would be interesting to perform a similar study in a situation where the dissection courses were compulsory.

Another important limitation of the present research is that, being a prospective study, conducted from the academic year 2010/2011 to 2014/2015, not enough time has yet elapsed to fully appreciate the impact of these two optional dissection courses on students' academic success in other undergraduate courses and in their overall undergraduate medical training. As a consequence, further and more protracted studies analogous the one herein described are warranted.

## CONCLUSION

These two optional dissection courses were perceived by students as important in consolidating their knowledge of anatomy and with regards to their general medical training. The academic success demonstrated by students attending these courses suggest that they played an important role in expanding and consolidating students' anatomical knowledge. For these reasons, similar dissection courses should be incorporated in modern medical curricula.

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